Foreign Exchange Time to Equilibrium for G-10 and Eastern Europe

Abstract

The evidence on theory-predicted price-to-exchange rate relation is at best very weak. This is a long run relation, given sticky price hypothesis, has been verified in few recent papers using different tests, including Theil’s divisia index method. This paper presents evidence of long run equilibria in two such regions from both developed and emerging economies, yet studied. These findings on the long run equilibrium and the length of time to equilibrium reported in this paper, we believe, help in some ways to enrich the literature on exchange rate behavior in both developed and emerging markets.

Keywords: Exchange Rates, Purchasing Power Parity, Divisia Index, Long Run
JEL classification: C43, F31

1. Introduction

Empirical evidence on exchange rate movements using Purchasing Power Parity (PPP) has been mixed, and is period-specific as well as country-specific. Studies by Abuaf and Jorion (1990), Manzur (1990), Manzur and Ariff (1995), Lothian and Taylor (1996, 2000, 2008), MacDonald and Ricci (2001), Parsley (2007), Kuo and Mikkola (2001), Smallwood (2007) and Xu (2004) demonstrated that PPP holds in the long run but others including Bayoumi and MacDonald (1999), Serletis and Gogas (2004) and Engel (2000) found no evidence or at best weak relationship between prices and exchange rates. An assessment of the vast PPP literature also reveals the use of three different approaches or research designs. Early studies used correlation tests about PPP holding as a central tendency with exchange rates. Later tests include time series unit root tests where exchange rate is considered to follow a random walk. In the later phase, cointegration analysis became popular for testing the long run equilibrium relationship. One major drawback of long horizon PPP literature is the problem that often only the world’s most developed countries are studied and those newly developed countries have not been extensively analysed. This paper is motivated thus by a desire to continue this research using a newer approach in sample design and test procedure on developed and less investigated emerging countries.

Since developing countries are where relative prices of goods have changed dramatically, the motivation for this research is to apply the new approach on developing countries in comparison with developed ones. We identify this relation within close-trading countries grouped as trade-linked regions. The dynamics of exchange rates suggest that it should be tested within a group of countries with close trading activities, and not as bilateral equilibrium in pairs of countries as has been the case in other research. Further Theil’s divisia index method is a consistent method that
enables the researcher to estimate the symmetric relationship in successive periods and provides a consistent method for aggregation and testing in a multi-country context. This paper offers a modest start on a new direction to overcome the shortcomings on studying exchange rate dynamics. Two specific objectives are to: a) establish the long-run pricing of currencies within regions; and b) measure the length of time to equilibrium under price parity and sticky price hypotheses.

The remainder of this paper is divided into five sections. The next section contains a brief overview of the current literature relevant to this study. Section three describes the divisia methodology, followed by presentation of findings in section four. The paper ends in section five with a conclusion.

2. Literature on Purchasing Power Parity
The price parity theorem (PPP) of exchange rates was first established by Cassel, 1918.\(^1\) This theory of purchasing power parity has been extensively tested by many renowned scholars using data from mostly the developed world. PPP has been viewed by many as a basis for international comparison of income and expenditure, an equilibrium condition; also as an efficient arbitrage condition in goods trade as a theory of exchange rate determination. PPP attempts to establish a common ground for cross-country comparison by linking currencies of different countries to price levels or more precisely, price differences across countries as the base.

Empirical evidence on exchange rate movements using Purchasing Power Parity (PPP) theorem has been mixed. A search in leading journals show articles on PPP from different perspectives from: specific country to specific industry; transitional economies versus OECD economies; speculative bubbles in prices; different methodologies used; short-run adjustment mechanism; etc. A recent paper terms this literature as “PPP Puzzle” by Bahrami-Oskooee et al. (2009). Using a vast data set for 113 countries with more recent test statistics, they showed that the evidence is closer to supporting the PPP.

The underlying theory is based on a simple goods market arbitrage argument with assumptions and states that identical goods should be similarly priced across countries, under the law of one price. While this notion appears simple enough, specifying comparative prices between two countries in the short run is difficult. This has led to a majority of empirical literature failing to verify that PPP holds.\(^2\) Most empirical tests do not attempt to compare identical basket of goods but use different country’s Consumer Price Index (CPI) or lately Producer Price Index (PPI) as a representation of goods prices across countries.

The relative version of PPP suggests that if a country’s inflation rate is relatively higher than its trading partner’s, that country will find its currency value falling in proportion to its relative price level increases. The exchange rate \(E\) as a function of \(P^d\) domestic prices and \(P^f\) foreign prices, where \(j\) represents country, \(t\) represents time period, as stated below:

\[
\ln E_{jt} = a_j + b_j \ln \left( \frac{P^d_j}{P^f_t} \right)_j + \mu_{jt} \tag{1}
\]

Much of the latest literature on establishing parity theorems that provide evidence on the theory indeed uses relative PPP. It is implicitly expected that relative PPP holds across countries with very different inflation rates. Overall, purchasing power parity is not a causal relationship but an equilibrium condition that must be satisfied in the longer term, an idea that has gained empirical verification only in the late 1990s.
When more exchange rates started to float or are on some form of basket-managed starting late 1973 – again now in 2000s - it was commonly assumed that exchange rates would quickly adjust to changes in relative price levels.\textsuperscript{3} With the already known failure of PPP holding in short run and years of high exchange rate volatility, it seemed that the theory of PPP had also failed to hold during the 1970s and 1980s.\textsuperscript{4} The apparent lack of evidence to uphold this theory under the current regimes acts as a motivating force that led to the development of sticky price, given evidence of the Philips curve on over-shooting exchange rates by Dornbusch (1976). Moreover, in the last two decades, unit root tests for PPP has been shown to have low power, hence researchers also often failed to reject the null hypothesis of the random walk.\textsuperscript{5}

In their survey of PPP literature, Froot and Rogoff (1994) concluded that PPP is not a short-run relationship and that prices do not offset exchange rate swings on a monthly or even annual basis. Frankel and Rose (1996) examined PPP with a panel of 150 countries for forty-five years and confirmed that PPP holds and their estimate implied a half-life of four years from PPP deviations. A study by Manzur (1990), which introduced a new approach, Divisia index numbers, tests PPP for both long and short run equilibrium for G7 countries as a group. The short run results vindicated the literature whereas the long run results were consistent with the PPP hypothesis and supported the sticky price explanation. The results also identified a broad measure of a length of the long run to be about five years for G7 developed countries.

Similar to Ho and Ariff (2008) which confirmed that long run PPP equilibrium for a group of Asia Pacific countries is five years, Manzur and Ariff (1995) tested PPP for five ASEAN countries in a trade-linked region and found that PPP holds well in the long run for these developing countries, but not in the short run. It reported a shorter time to equilibrium for these developing countries, whose goods prices are less sticky than in the developed countries. A similar test using the cointegration approach failed to reveal the equilibrium in the long run for the same countries, and this is due to the power of the method used and the tests on individual country basis despite the ASEAN countries forming a close trading group: Baharumshah and Ariff (1997).

3. **Divisia Index Methodology**

Divisia index is an appropriate technique for testing PPP since it enables a trade-linked group of countries to be investigated jointly to reveal exchange rate dynamics through trading activities. It requires the construction of an index of variables using the size of each economy as weights to represent the relationship among a group of trade-related countries. Theil’s (1967) well-known methodology of Divisia moments of prices and quantities provides a noble index method for joint tests to be carried out since exchange rates of trade-linked countries are more likely to be jointly-determined.

Divisia parameters or moments estimate the symmetric relationship in successive periods and provide a consistent method for aggregation and testing. This approach provides a test for each observation in the sample period, whereas a regression method provides a test over an entire period. A comprehensive discussion on the Divisia Index methodology is detailed in Appendix A. The index is a value-weighted price and exchange rate series with the second and third moments computed differently to those of the normal series. The final equilibrium relationship is tested in the following equation:

\[
\rho_t^{p_s} = \frac{V_t^{p_s}}{\sqrt{V_t^{p_s}V_t^{s}}} = 1
\]
The left-hand term is the correlation coefficient computed using the divisia moments on the right-hand side. Equilibrium between prices and exchange rate is achieved when this test value approximates 1.00. Our hypothesis of long-run PPP will be accepted if this value is close to unity.

4. Findings

Results with Long-Run Data

The results to be discussed in this section pertains to 2 trade-linked regions: (i) the G-10 developed countries region including Canada, France Germany, Italy, Japan, Netherlands, Sweden, Switzerland and the U. K. and (ii) the developing Eastern European region consisting of Czech Republic, Hungary, Poland, Romania, Russia, Slovak Republic, Slovenia and Turkey.6

The data series are quarterly and yearly interval data: see summary in Table 1. These data relate to exchange rates between individual countries, and the United States (U.S.) dollar (as reported in IFS, line rf) as the foreign unit as observed at the end of observation periods.7

[Insert Table 1 here]

The International Financial Statistics (IFS) CD-ROM published by IMF is the major source. Price variables include Consumer Price Index (CPI) (IFS, line 64) of individual countries and Nominal GDP (IFS, line 99B) is used for the GDP weights.8

The proxy for domestic prices for each country ( \( p_t \)) is measured by consumer prices. The averaged individual country’s proportion of GDP in the region is used as weights ( \( w_i \)). Tables 2 and 3 provide the averages over a period of nearly three decades for the region of G-10 countries and for more than one decade for the Eastern Europe region. It can be used to analyse the long run relationships between exchange rates and prices for each of the two regions. Since PPP implies that changes in exchange rates should correspond to changes in inflation differentials, columns (2) and (4) of Tables 2 and 3 show that these two variables are rather closely related in the different regions.

[Insert Table 2 and 3 here]

For the region of developed countries in Table 2, the changes in exchange rates and inflation differentials are almost always very closely linked with matching direction of change. Similar results were obtained in Manzur (1990) where only six countries were studied and in his study, both Japan and Germany provided appreciation in exchange rates due to lower inflation in these countries relative to the U.S. In this study, not only are Germany and Japan having lower inflation rates, the Netherlands and Switzerland are also countries with lower relative inflation rates and therefore experience appreciation of their currency values.

For the region of Eastern Europe, it is not surprising to note that the relationship between price differentials and exchange rate changes are positively related in Table 3. However, since all of these countries have relatively higher inflation rates than the U.S., their exchange rates have all depreciated relative to the US dollar except for a slight appreciation in the Czech Republic which might be due to domestic exchange rate policy.

This relationship can be more clearly observed with a scatter plot of the changes in exchange rates against inflation differentials: Figures 1 and 2. The developed country region reveals a very symmetrical relation with all points being relatively close to the 45 degree line which shows that inflation differentials and changes in exchange rates are very closely correlated as in the vintage textbook graphs of theoretical prediction.
The observation in Figure 2 for the Eastern European region is also similar to those of the developed countries.

[Insert Figures 1 and 2 here]

The statistics of Divisia moments for price and exchange rate variables are presented in Table 4. The Divisia index for exchange rates, $DS$, is given in row (1). This is the average of the sum of all the countries’ weighted average of the log change in exchange rates ($\bar{w}_D S_D$) as in the first set of Tables 2 to 3 adjusted with country weights. A similar procedure is carried out for the application of the other measures to the long run data. Divisia indices for prices in domestic currencies and in U.S. dollars are in rows (2) and (3), respectively. Divisia variances of exchange rates and prices are given in rows (4) to (6) and the domestic-currency price-exchange rate covariance and the corresponding correlation coefficient are presented in rows (7) and (8) respectively.

[Insert Table 4 here]

The results from Table 4 column (1) reveal that long run Divisia moments for the G-10 developed countries with US dollar price variance ($V^{pp}$) of 0.03 given in row (6) is small in comparison with the other two variances, 0.43 for $V^{*}$ and 0.49 for $V^{p}$ and $p'$. This is close to and supports the prediction of PPP where $V^{pp} = 0$. The variances of exchange rates and domestic-currency prices of 0.43 and 0.49 given in rows (4) and (5) are almost equal and this is again in accordance with the implications of PPP which confirms that relative inflation deviation is close to zero and the variance of exchange rate should be almost equal to variance of domestic-currency prices (Equation A14). Moreover, the value of the domestic-currency price-exchange rate covariance of 0.44 in row (7) is also almost equal to the domestic-currency price and exchange rate variances in row (5). Finally the value of the domestic-currency price-exchange rate correlation coefficient is 0.96 in the long run and this is obviously close to unity which is implied by PPP (Equation 2).

Similarly, for the region of Eastern European countries, column (3) provides consistent results which are not unlike those of the other two regions. The US dollar price variance is small relative to the other two variances. The covariance of domestic-currency price-exchange rate of 2.04 is also rather close to the variances of exchange rate and domestic currency prices of 1.87 and 2.25 respectively. Domestic-currency price-exchange rate correlation coefficient of 0.99 for the long run is also consistent with PPP. In summary, the long run data results for the developed and developing countries regions are consistent with the PPP hypothesis.

**Results with Short-Run Data**

To provide comparison with the vast literature, we derive results for the short run equilibrium, knowing very well, it is unlikely to hold. There are two reasons for this: there has been no evidence to support short run equilibrium, and the tests were done using individual countries, unlike our region-based analysis. Similar to the above section on long run data, this section applies the methodology to quarterly data for the three regions of countries. The average change in prices and exchange rates are summarized in Table 5. Column (1) refers to the mean $n$-country average exchange rate changes and column (2) is the mean domestic-currency average inflation rate. Column (3) provides the mean U.S. inflation rate and column (4) the average Divisia mean of PPP deviations.

[Insert Table 5 here]

For the G-10 developed countries region, the average exchange rates appreciate (relative to US dollars) by about 0.45 per cent per quarter while domestic-currency
prices increase by an average of 0.71 per cent, and moreover, the U.S. relative prices rise by 0.97 per cent. Therefore the average deviation from PPP: \( E = DS - (DP' - DP) \) is \(-0.00451 - 0.00706 + 0.00971 = -0.00186\) per cent per quarter, as in column (4).

The Eastern Europe region has an average exchange rate depreciation of about 5.25 per cent per quarter, domestic-currency prices increase by an average of 7.47 per cent which is much higher than the U.S. relative price increase of 0.38 per cent resulting in depreciation of the currency value. This again results in an average deviation from PPP of \(0.05246 - 0.0747 + 0.00379 = -0.01845\) as in column (4).

A brief look at the relationship between average exchange rate changes and inflation differentials for the shorter term in Figure 3 and 4 shows almost no relation between exchange rates and prices for the regions in the short run. This is also consistent with theoretical and empirical beliefs that PPP does not hold well in the short run.

Further investigation into the variances, covariances and correlation coefficient for the quarterly data in Table 6 reinforces the failure to find short run relation between exchange rates and prices. This table provides mean values of short run quarterly data, analogous to rows (4) to (8) of Table 4. The US dollar price variance \(V_{pp}^\), on average approximates exchange rate variance \(V_{ss}^{\prime}\), instead of becoming zero as implied by PPP (Equation A15).

It is not surprising to note that the correlation coefficients \((C_{ps}')\) for the two regions are low relative to their long run figures. The mean price-exchange rate correlation coefficient for G-10 developed countries is only 0.13 and for the Eastern Europe region is 0.46. This is very different from unity according to PPP (Equation 2). It can be concluded from these results that short run changes in exchange rates and prices are not in accordance with the price parity theory for the two regions in this study. However, the long run results were by way of the theory prediction.

**Time to equilibrium**

To investigate the time to equilibrium for PPP in the two regions, multi-period Divisia price and exchange rate correlation statistics are reported in this section. Changes in prices and exchange rates are computed over yearly, two yearly and beyond. Even though previous studies utilised quarterly data, this study prefers the yearly data due to the accuracy of yearly data relative to other similar computation process. As the comparison periods become further and further apart the number of observations becomes smaller and smaller. Results for the two regions are shown in Tables 7 and 8.

The results for G-10 developed countries are shown in Table 7. Each column in the table provides the respective Divisia moments for the given length of change in time period. It is interesting to note that the corresponding second-order Divisia moments still follows where variances of US dollar prices tend to be relatively low and the variances of exchange rates and domestic-currency prices tend to be very close to each other as explained in earlier section. For all periods of study, weighted log-change in exchange rates is almost always equal to the difference between the log-change in domestic prices less the log-change in US dollar prices which is consistent with theory (Equation A4).
Note that both the covariance and the correlation coefficient of domestic price-exchange rate increase as the length of time period increases and eventually the correlation coefficient becomes near to unity. In the case of the G-10 developed region, it is shown that long run PPP is achieved after a period of six years. This result is also consistent with Manzur’s (1990) study of only six developed nations with long run equilibrium of about five years. This can be attributed to the larger number of countries involved and greater fluctuation in worldwide exchange rates in the recent years included in our study.

New findings for the region of developing countries in Eastern Europe summarised in Table 8 shows that the corresponding log-change in exchange rates in row (1) is almost always equal to the difference between the weighed log-change in domestic prices and the weighted log-change in US dollar prices. This is consistent with PPP in that changes in prices correspond to changes in exchange rates.

It is also interesting to note that variances of exchanges rates and domestic currency prices are close to each other and that the variances of prices tend to be relatively low according to theory. Both the covariances and correlation coefficients increase as the length of time period increases. Developing countries in this region achieve long run equilibrium at a slightly shorter time period than developed countries: this is due to trade of these countries being dominated by primary and extractive outputs with faster price adjustment. Table 8 shows that for Eastern European countries, the long run PPP is almost instantaneous at one to two years. Again this is due to the region’s dependence on trading in tourism and consumer goods.

[Insert Table 8 here]

In summary, it can be seen that the values of the correlation coefficient initially increases with the length of the change and then stabilises to reach values of 0.8 in slightly less than six years for G-10 developed region and two years for the Eastern Europe region. Thus the results tend to identify the time to equilibrium for the different regions at different time. This is only a broad measure of the length of the long run insofar as PPP is concerned for the two regions of countries with the latest data available.

5. Conclusion
The results reported in this paper are from applying Divisia index numbers methodology to test relative purchasing power parity in each of the two regions of trade-linked countries, both developed and developing. The results indicate clearly for the first time the predictions of purchasing power and sticky price hypotheses. Interestingly, the study provides new evidence that supports longer term PPP relationships for three groups of countries especially for the groups of developing countries which has yet to be studied even on bilateral basis. As expected, the theory does not hold in the short run because of sticky prices, which is consistent with empirical findings. It is also fascinating to note that the broad measure of the length of long run equilibrium are approximately six years and two years for the region of G-10 developed countries and Eastern Europe, respectively.

PPP models ignore trade and capital flows as well as other country specific fundamentals therefore further investigation should look into other fundamentals beyond PPP in determining exchange rates. This study looks at PPP alone and provides these new findings that PPP could explain movements in exchange rates in the longer term for regions of countries with different levels of development. We conclude that PPP is still alive, and it takes different length of time to equilibrium.
APPENDIX A

Divisia Index Method

Following the specifications in Manzur (1990), the approach can be briefly explained as follows: let there be \( n \) countries in the sample and let the price levels in these countries in terms of domestic currencies be \( p_1', ..., p_n' \). If the \( n \) exchange rates (defined as the domestic currency cost of US$1) are \( s_1, ..., s_n \), then these price levels in terms of US dollars are \( p_i/s_i, ..., p_n/s_n \), which may be written as \( p_1, ..., p_n \). Consider a consumer who purchases the quantities \( q_1, ..., q_n \) from the \( n \) countries. The cost of this basket in US dollars is \( p_1q_1 + ... + p_nq_n = M \). Let \( w_i = p_iq_i/M \) be the share of \( i \) in \( M \). Writing \( D \) for log-change operator \( (Dx = \log x - \log x_{-1}) \), we define the Divisia indices for the \( n \) countries as:

\[
D_P = \sum_{t=1}^{n} \bar{w}_{it} DP_{it} \tag{A1}
\]

\[
D_P' = \sum_{t=1}^{n} \bar{w}_{it} DP_{it}' \tag{A2}
\]

\[
DS_i = \sum_{t=1}^{n} \bar{w}_{it} DS_{it} \tag{A3}
\]

Where \( \bar{w}_t = (w_{it} + w_{i,t-1})/2 \) is the arithmetic average of \( w_{it} \) in periods \( t-1 \) and \( t \). From the three equations above, Divisia index of world inflation measured in terms of domestic currencies and the weighted average change in the values of the \( n \) currencies relative to the US dollar is:

\[
D_P = D_P' - D_S \tag{A4}
\]

This equation states that world inflation measured in terms of dollars \((DP)\) equals the corresponding concept measured in terms of the domestic currencies \((DP')\) minus the average depreciation of the \( n \) currencies. The indices defined above are weighted means of the price and exchange rate log-changes, the weights being the \( \bar{w}_{it} \)'s. These indices are the weighted first-order Divisia moments of the \( Dp_i \)'s, \( Dp_i' \)'s and \( DS_i \)'s. The corresponding second-order moments are the Divisia variances:

\[
V^{PP}_{it} = \sum_{t=1}^{n} \bar{w}_{it} (Dp_{it} - Dp_i)^2 \tag{A5}
\]

\[
V^{PP'}_{it} = \sum_{t=1}^{n} \bar{w}_{it} (Dp_{it}' - Dp_i')^2 \text{ and} \tag{A6}
\]

\[
V^{SS}_{it} = \sum_{t=1}^{n} \bar{w}_{it} (DS_{it} - DS_i)^2 \tag{A7}
\]

These measure the degree to which prices and exchange rates vary disproportionately across countries. To measure the co-movement of prices and exchange rates across countries, the associated Divisia price-exchange rate covariances are:

\[
V^{PS}_{it} = \sum_{t=1}^{n} \bar{w}_{it} (Dp_{it} - Dp_i)(DS_{it} - DS_i) \tag{A8}
\]
\[ V_{it}^{p's} = \sum_{i=1}^{n} \bar{w}_i (Dp_{it}' - DP_{i}) (DS_{it} - DS) \]  

(A9)

while the domestic price-exchange rate correlation coefficient is:

\[ C_i = V_{it}^{p's} / (V_{it}^{p'p'} \times V_{it}^{ss})^{1/2} \]  

(A10)

The relative version of PPP states that the percentage change in the exchange rate is equal to the inflation differential:

\[ Ds_{it} = Dp_{it}' - DP_{it} + e_{it} \]  

(A11)

where \( Dp_{it}' \) is the inflation in the USA and \( e_{it} \) is the deviation from PPP. Under PPP, the deviation \( e_{it} = 0 \) and \( V_{it}^{p'p'} = V_{it}^{s's} = V_{it}^{pp} = V_{it}^{ps} = 0 \) and \( C_i = 1 \). Thus:

\[ DS_{i} = DP_{i}' - DP_{it} + E_{i} \]  

(A12)

where \( E_{i} = \sum_{i=1}^{n} \bar{w}_i e_{it} \) is the Divisia mean (or weighted mean) of the deviations from PPP. This equation (A12) states that the \( n \)-country average change in exchange rates is equal to the difference between the \( n \)-country average inflation rate in terms of domestic currencies and that in the USA, plus an average deviation. As PPP implies \( e_{it} = E_{i} = 0 \), this means that the \( n \)-country average inflation rate in dollars (DP) equals inflation in the USA (Dp). Therefore,

\[ DS_{it} - DS_{i} = Dp_{it}' - DP_{it} + e_{it} - E_{i} \]  

(A13)

the change in the \( i \)th exchange rate relative to \( n \)-country average equals the deviation of inflation in \( i \) from the \( n \)-country average, which is an inflation differential, plus a relative deviation, \( e_{it} - E_{i} \). Note that the Divisia mean of the relative deviations is zero:

\[ \sum_{i=1}^{n} \bar{w}_i (e_{it} - E_{i}) = 0 \] . Also note that the above equation is definitely true and that under PPP, \( e_{it} = E_{i} = 0 \). Also from the above, we can obtain:

\[ V_{it}^{ss} = V_{it}^{p'p'} = V_{it}^{p's} \]  

(A14)

\[ V_{it}^{pp} = V_{it}^{ps} = 0 \] , and

(A15)

\[ \rho_{it}^{p's} = \frac{V_{it}^{p's}}{\sqrt{V_{it}^{p'p'}V_{it}^{ss}}} = 1 \]  

(A16)

Equation (A16) measures the strength of the magnitude of the relationship between prices and exchange rates and it is implied to be equal to one. That is, under PPP (1) the domestic-currency price and exchange rate variances and their covariance all coincide; (2) the variance of US dollar prices and their covariance with exchange rates both vanish; and (3) domestic prices and exchange rate are perfectly correlated under PPP.

---

1 Recent writers have attributed this theory to an earlier origin to Spanish writers in the eighteenth century.

2 Empirical work that has led to conflicting empirical findings for PPP includes MacDonald (1993), Rogoff (1996), Edison, Gragnon and Melick (1997), Cheng (1999), Edwards and Savastano (1999), Kim (1990), Cheung, Chinn and Pascual (2003) and Bayoumi and MacDonald (1999). They have all found no clear evidence or at best, very weak relationship between inflation and exchange rates.

3 With the collapse of the Bretton Woods system, countries started to float their exchange rates instead of fixing them to the dollar.
Henry and Olekaln’s (2002) study on Australia found little evidence for long run equilibrium between exchange rate and prices. In a similar view, Adler and Lehman (1983) found that the deviations from PPP follow a random walk without reverting back to PPP for 43 countries.


In determining which countries to include, the trade proportions among the region were tabulated, and the countries selected based on how closely they are linked.

These exchange rate quotations can be expressed in either a unit of foreign currency (Direct quote) or a local unit expressed in foreign equivalent (Indirect quote). A direct exchange rate quotation gives the home currency price of in terms of foreign currency whereas the indirect quote gives the one unit home currency equivalent in foreign currency. They are actually the reciprocal of each other. In order to avoid confusion, direct quotations are used, as is the practice in the literature, in this study unless stated otherwise.

A compilation of data used in this study is available upon request.

As mentioned in Manzur (1990) as well as Manzur and Ariff (1995) the long run cut off threshold for correlation coefficient close to unity is when it is above 0.8 as also used by other researchers.

REFERENCES


FIGURES

Figure 1: Changes in Exchange Rates and Inflation Differentials for G-10 Developed Countries

Figure 2: Changes in Exchange Rates and Inflation Differentials for Eastern Europe Region
Figure 3: Exchange Rate Changes and Inflation Differentials for Developed Countries in the Short Run

Figure 4: Exchange Rate Changes and Inflation Differentials for Eastern European Region in the Short Run
## TABLES

**Table 1: Data Length for Different Regions of Countries**

The study includes countries in three closely trading regions with: nine countries in the G-10 developed countries region for 25 years and 100 quarterly observations and eight countries in the Eastern Europe region for 11 years and 44 quarterly observations.

<table>
<thead>
<tr>
<th>Region</th>
<th>G-10 Countries</th>
<th>Eastern Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of countries</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>

**Table 2: Summary Statistics of Yearly Exchange Rate and Inflation Changes with Proportion of GDP for G-10 Developed Countries, 1974 – 1998.**

The total number of observations for each country in the region is 25 years. Column (2) is the natural log change of exchange rates, while column (3) is the natural log change in domestic currency prices. Column (4) measures the difference between domestic currency prices and US dollar prices and column (5) indicates the average GDP weights of individual country in the region.

<table>
<thead>
<tr>
<th>G-10 developed countries</th>
<th>Average Exchange Rate ln change</th>
<th>Average Price ln change</th>
<th>Average Inflation Differential ln change</th>
<th>Mean GDP share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( D\bar{\pi}_i \times 100 )</td>
<td>( D\bar{p}_i \times 100 )</td>
<td>( (D\bar{p}_i - D\bar{\pi}_i) \times 100 )</td>
<td>( \bar{w} \times 100 )</td>
</tr>
<tr>
<td>Canada</td>
<td>0.10883</td>
<td>0.28095</td>
<td>0.06982</td>
<td>6.0249</td>
</tr>
<tr>
<td>France</td>
<td>0.05892</td>
<td>0.34234</td>
<td>0.13121</td>
<td>13.7858</td>
</tr>
<tr>
<td>Germany</td>
<td>-0.09170</td>
<td>0.12608</td>
<td>-0.08505</td>
<td>18.0872</td>
</tr>
<tr>
<td>Italy</td>
<td>0.23358</td>
<td>0.53894</td>
<td>0.32781</td>
<td>10.6581</td>
</tr>
<tr>
<td>Japan</td>
<td>-0.23920</td>
<td>0.04633</td>
<td>-0.16480</td>
<td>32.2977</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-0.07093</td>
<td>0.15215</td>
<td>-0.05898</td>
<td>3.5512</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.17020</td>
<td>0.38442</td>
<td>0.17329</td>
<td>2.4756</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.15252</td>
<td>0.17066</td>
<td>-0.04047</td>
<td>2.4049</td>
</tr>
<tr>
<td>U.K.</td>
<td>0.08690</td>
<td>0.44459</td>
<td>0.23346</td>
<td>10.7148</td>
</tr>
<tr>
<td>U.S.</td>
<td></td>
<td>0.21112</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total number of observations for each country in the region is 11 years. Column (2) is the natural log change of exchange rates, while column (3) is the natural log change in domestic currency prices. Column (4) measures the difference between domestic currency prices and US dollar prices and column (5) indicates the average GDP weights of individual country in the region.

<table>
<thead>
<tr>
<th>Eastern Europe</th>
<th>Average Exchange Rate In change $\Delta \overline{x}_i \times 100$</th>
<th>Average Price In change $\Delta \overline{p}_i \times 100$</th>
<th>Average Inflation Differential In change $(\Delta \overline{p}_i - \Delta \overline{p}_d) \times 100$</th>
<th>Mean GDP share $\overline{w} \times 100$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech Rep</td>
<td>-0.01818</td>
<td>0.10996</td>
<td>0.05908</td>
<td>10.0411</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.19965</td>
<td>0.35357</td>
<td>0.30269</td>
<td>8.8197</td>
</tr>
<tr>
<td>Poland</td>
<td>0.20743</td>
<td>0.24580</td>
<td>0.19492</td>
<td>26.9639</td>
</tr>
<tr>
<td>Romania</td>
<td>1.26857</td>
<td>1.59275</td>
<td>1.54187</td>
<td>6.2490</td>
</tr>
<tr>
<td>Russia</td>
<td>0.92399</td>
<td>0.91695</td>
<td>0.86607</td>
<td>41.7398</td>
</tr>
<tr>
<td>Slovak</td>
<td>0.05457</td>
<td>0.20571</td>
<td>0.15483</td>
<td>3.8349</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.20375</td>
<td>0.21916</td>
<td>0.16828</td>
<td>2.3219</td>
</tr>
<tr>
<td>Turkey</td>
<td>1.57667</td>
<td>1.89553</td>
<td>1.84465</td>
<td>0.0030</td>
</tr>
<tr>
<td>US</td>
<td>0.05088</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4: Divisia Moments of Exchange Rates and Prices for the Regions: Long Run Data

Divisia indices in the long run for log-changes in exchange rates is in row (1), indices for price changes in domestic currencies in row (2) and for US dollar price changes is in row (3). The corresponding second-order moments and Divisia variances for exchange rates is in row (4), domestic currency prices in row (5) and US dollar prices in row (6). The measurement of co-movement in prices and exchange rates are price-exchange rate covariance in row (7) and their correlation coefficient in row (8). PPP in the long run for the three regions of countries is achieved when the correlation coefficient for domestic currency prices and exchange rates becomes close to unity.

<table>
<thead>
<tr>
<th>Region</th>
<th>Exchange rate</th>
<th>Price Index Domestic currencies</th>
<th>US Dollar</th>
<th>Deviations from PPP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DS</td>
<td>DP</td>
<td>DP</td>
<td>E</td>
</tr>
<tr>
<td>G-10 Countries</td>
<td>-0.06431</td>
<td>1.21945</td>
<td>1.28375</td>
<td>-0.00185</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>2.05254</td>
<td>2.64237</td>
<td>0.58983</td>
<td></td>
</tr>
</tbody>
</table>

Table 5: Divisia Indices of Mean Quarterly Exchange Rates and Prices: Short-Run Data

The short run Divisia Index moments for weighted natural logarithm change in: (a) exchange rates in column (1), (b) domestic currency prices in column (2) and (c) US dollar prices in column (3). Column (4) provides the deviations from PPP.

<table>
<thead>
<tr>
<th>Region</th>
<th>Exchange Rate (1)</th>
<th>Price Index of domestic currencies (2)</th>
<th>US Inflation (3)</th>
<th>Deviations from PPP (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DS</td>
<td>DP'</td>
<td>DP</td>
<td>E</td>
</tr>
<tr>
<td>G-10 Countries</td>
<td>-0.00451</td>
<td>0.00706</td>
<td>0.00971</td>
<td>-0.00185</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>0.05246</td>
<td>0.07470</td>
<td>0.00379</td>
<td>-0.01844</td>
</tr>
</tbody>
</table>
### Table 6: Divisia Indices of Mean Quarterly Covariances of Exchange Rates and Prices: Short-Run Data

The second-order moments and Divisia variances for: (a) exchange rates in column (1), (b) domestic currency prices in column (2) and (c) US dollar prices in column (3). The measurement of co-movement in prices and exchange rates are price-exchange rate covariance in column (4) and their correlation coefficient in column (5). PPP in the long run for the three regions of countries is achieved when the correlation coefficient for domestic currency prices and exchange rates becomes close to unity.

<table>
<thead>
<tr>
<th>Region</th>
<th>Variance of Exchange Rate $\sigma^2$</th>
<th>Variance of Domestic-currency prices $\sigma^{dp^2}$</th>
<th>Variance of US$ prices $\sigma^{us^2}$</th>
<th>Price–exchange rate Covariance $\sigma^{ps}$</th>
<th>Correlation coefficient $C^{ps}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed Countries</td>
<td>0.00105</td>
<td>0.00011</td>
<td>0.00105</td>
<td>0.00005</td>
<td>0.13050</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>0.01039</td>
<td>0.00943</td>
<td>0.00683</td>
<td>0.00650</td>
<td>0.46321</td>
</tr>
</tbody>
</table>

### Table 7: Divisia Indices for Exchange Rates and Prices for Various Changes in Yearly Time Periods: G-10 Developed Countries

Divisia indices in the long run for log-changes in exchange rates is in row (1), indices for price changes in domestic currencies in row (2) and for US dollar price changes is in row (3). The corresponding second-order moments and Divisia variances for: (a) exchange rates in row (4), (b) domestic currency prices in row (5) and (c) US dollar prices in row (6). The measurement of co-movement in prices and exchange rates are price-exchange rate covariance in row (7) and their correlation coefficient in row (8). PPP in the long run for the three regions of countries is achieved when the correlation coefficient for domestic currency prices and exchange rates becomes close to unity.

<table>
<thead>
<tr>
<th>Yearly</th>
<th>2 Yearly</th>
<th>3 Yearly</th>
<th>4 Yearly</th>
<th>5 Yearly</th>
<th>6 Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Exchange rate</td>
<td>$DS$</td>
<td>-0.00851</td>
<td>-0.01546</td>
<td>-0.02311</td>
<td>-0.03049</td>
</tr>
<tr>
<td>(2) Price Index</td>
<td>$DP^d$</td>
<td>0.04204</td>
<td>0.07412</td>
<td>0.11133</td>
<td>0.14945</td>
</tr>
<tr>
<td>(3) $US$</td>
<td>$DP^u$</td>
<td>0.05055</td>
<td>0.08958</td>
<td>0.13445</td>
<td>0.17994</td>
</tr>
<tr>
<td>(4) Variance of</td>
<td>$V^{rs^2}$</td>
<td>0.00583</td>
<td>0.01319</td>
<td>0.05296</td>
<td>0.02927</td>
</tr>
<tr>
<td>(5) Variance of</td>
<td>$V^{dp}$</td>
<td>0.00127</td>
<td>0.00455</td>
<td>0.01005</td>
<td>0.01652</td>
</tr>
<tr>
<td>(6) US $ prices</td>
<td>$V^{us}$</td>
<td>0.00504</td>
<td>0.00942</td>
<td>0.00817</td>
<td>0.01549</td>
</tr>
<tr>
<td>(7) Price-exchange rate</td>
<td>$V^{us}$</td>
<td>0.00136</td>
<td>0.00416</td>
<td>0.00901</td>
<td>0.01515</td>
</tr>
<tr>
<td>(8) Correlation coefficient</td>
<td>$C^{ps}$</td>
<td>0.66595</td>
<td>0.39837</td>
<td>0.33529</td>
<td>0.34151</td>
</tr>
</tbody>
</table>
Table 8: Divisia Indices for Exchange Rates and Prices for Various Changes in Yearly Time Periods: Eastern Europe

Divisia indices in the long run for log-changes in exchange rates is in row (1), indices for price changes in domestic currencies in row (2) and for US dollar price changes is in row (3). The corresponding second-order moments and Divisia variances for: (a) exchange rates in row (4), (b) domestic currency prices in row (5) and (c) US dollar prices in row (6). The measurement of co-movement in prices and exchange rates are price-exchange rate covariance in row (7) and their correlation coefficient in row (8). PPP in the long run for the three regions of countries is achieved when the correlation coefficient for domestic currency prices and exchange rates becomes close to unity.

<table>
<thead>
<tr>
<th>(1) Exchange rate</th>
<th>(2) Price Index</th>
<th>(3) Variance of</th>
<th>(4) Variance</th>
<th>(5) Variance</th>
<th>(6) Variance</th>
<th>(7) Covariance</th>
<th>(8) Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS</td>
<td>DP</td>
<td>DP</td>
<td>DS</td>
<td>DP</td>
<td>DS</td>
<td>$US</td>
<td>Domestic</td>
</tr>
<tr>
<td>0.16725</td>
<td>0.22986</td>
<td>0.06261</td>
<td>0.02134</td>
<td>0.04666</td>
<td>0.8180</td>
<td>0.36827</td>
<td>0.49296</td>
</tr>
<tr>
<td>0.36827</td>
<td>0.49296</td>
<td>0.12469</td>
<td>0.02796</td>
<td>0.16045</td>
<td>0.90197</td>
<td>0.44138</td>
<td>0.60199</td>
</tr>
<tr>
<td>0.44138</td>
<td>0.60199</td>
<td>0.16061</td>
<td>0.04754</td>
<td>0.13924</td>
<td>0.85981</td>
<td>0.53065</td>
<td>0.59787</td>
</tr>
<tr>
<td>0.53065</td>
<td></td>
<td>0.06722</td>
<td>0.02960</td>
<td>0.20115</td>
<td>0.95220</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Yearly 2 Yearly 3 Yearly 4 Yearly